producing photographic effects always appear to produce strong fluorescent effects on platino-cyanide of barium, so that the fluorescence of this affords an indication of the photographic efficiency of the radiations emitted from the tube.

Ralph R. Lawrence.

Massachusetts Institute of Technology,
Boston, February 26.

Is it quite correct, as Prof. Lodge puts it, to call the X-rays *anodic* because they start from a point (surface of glass, or of metal foil, &c.) opposite the kathode? It may be true that a surface upon which the kathodic discharges are being directed acquires thereby some properties common to the anode: but it is not an actual anode. Further, I think that so far there is no proof that these rays start from an anode unless that anode is itself in the line of the kathodic discharge. Hence I submit that *anti-kathodic* would be a more correct term to use in describing them. They can certainly be made to start from a portion of the kathode itself by shaping it so as to concentrate the kathodic discharges (or "radiant matter") upon a prolongation of itself.

Whilst dealing with this point, might I mention that a phosphorescent enamel, made by incorporating calcium sulphide in a very fusible enamel-glass, appears to form an excellent anti-kathodic surface for generating X-rays.

Silvanus P. Thompson.

Finsbury Technical College, March 9.

We enclose a print of a "Röntgen" photograph taken by us some time ago, which shows very clearly that it is to the mineral constituents that bone owes its opacity to the "X-rays." Two human finger-bones were obtained as nearly alike as possible. One was decalcified by treatment with dilute hydrochloric acid for some days, the other being soaked in water for the same period. The calcium phosphate, carbonate, &c., dissolved by the hydrochloric acid, were precipitated by ammonia and ammonium carbonate, and the precipitate, after washing, was spread on paper, so as to cover an area about equal to that which would be covered by the original bone. This precipitate, together with the bone which had merely been soaked in water, and the "decalcified" bone (which had shrunk during treatment with the acid), were then placed upon a photographic plate and exposed in a cardboard box to the radiations from a Crookes' tube excited by a small "Tesla" apparatus.

The picture thus obtained, shows clearly that while the decalcified bone is almost without action on the "X-rays," the mineral matter is practically as opaque as the bone before treatment with acid.

The print shows, however, that both the original bone and the calcium phosphate are only relatively opaque, but that they do allow some "rays" to pass, for the photograph shows half-tones, and not merely an outline.

J. D. Cormack.
Herbert Ingle.

The Yorkshire College, Leeds, March 4.

Remembering that scientific men are pledged, beyond all others, to accuracy and observance of rule, I am emboldened to protest against the use of two words which are sometimes employed to describe the pictures produced through the agency of Röntgen's rays. I mean "shadowgram" and "radiogram."

Both of these offend against a primary rule for the formation of new compound words, which requires that all of the component parts of any word shall be derived from one and the same language.

If a word be desired which shall signify a picture produced by rays, let us go to the Greek language only, and form the word "actinogram"; or to the Latin language only, and form the word "radioscript"; or else let us be content with some purely English compound, such as "ray-sketch."

G. H. P.

The Aurora at Waterford.

After a boisterous day and a barometer that went down to 28·85, we were favoured last (Wednesday) night with an auroral display. It was first seen here at 8 o'clock, when it appeared in a cloudless, starlit sky as a sheaf of light springing from the western point of the horizon, and stretching along an arc of 30° up towards the Pleiades.

Its colour, at first silvery white, gradually faded away, reappearing in thin streaks and irregular patches of yellowish light in various parts of the sky between north and west.

At 10.30, it was round in the north. At one time, six well-distanced streaks were counted. They seemed to converge slightly towards the zenith. The light was mainly yellowish, but tinged here and there with pulsating reddish rays. The flickering, or fluctuation in colour and brightness, was distinctly noticeable.

The phenomenon was not observed after 11.30.

As auroræ are essentially electrical in character, having some analogies with the brush discharge, it would be interesting to know whether, like the brush discharge from induction coils and influence machines, *shadowgraphs* might be taken by means of these weird rays. Opportunities for testing their photographic qualities occur very frequently in higher latitudes than ours, and even nightly in circumpolar regions, the home of this interesting phenomenon.

M. F. O'Reilly.

De La Salle Training College, Waterford, March 5.

An Unusual Meteor.

At 8.31 on Sunday evening, March 1, when half a mile north of York Minster, I caught sight of a meteor slowly falling vertically almost due east. It was then passing over the two small stars ν and ξ Ursæ Majoris, which at the time were at an altitude of 43°, azimuth 5° north of east. Seeing that it meant to last awhile, I proceeded to repeat the alphabet in the orthodox manner (once through, each letter quickly but distinctly enunciated, requiring 4 seconds). Having gone over it twice, I must confess that my amazement at the meteor's duration made me pause. But it kept on, so I continued, getting through it twice more. Then, after a second involuntary but very unscientific pause, I finished the alphabet a fifth time before the phenomenon came to a close. In all, I must have watched it at least 25 seconds. After some 10 seconds, when about the same altitude as β Leonis (24°), a smaller meteor (fourth magnitude) appeared 1° to the left, at an angle of about 40°, and, proceeding at the same speed of under 2° per second, lasted 3 or 4 seconds. The original, of which this was doubtless a fragment, was between first and second magnitude, but with a distinct disc, and was followed by a train of sparks, reddish like itself, which was never more than 2° or 3° long, or lasting only 1 or 2 seconds. The fragment had also a slight train. The main mass seemed to pause slightly about this spot, perhaps because of this explosion. From the first it moved slower and slower, doubtless an effect of perspective, and finally disappeared almost due east (within 5° north of east), only 5° or so above the horizon, in the unusually clear sky just above the rising moon.

Whilst making notes, a gentleman came by, who said that he had seen it earlier, when as high as, and very near τ and μ Ursæ Majoris (the hind paw), or about an altitude of 58°, 5° north of east. Thus its angular path was 53°. As the additional distance was nearly half that observed by myself, it must have been visible for at least 7 seconds before I saw it, or 32 seconds in all. This makes due allowance for its apparently quicker motion at first. But the gentleman himself thought that he had not seen the actual commencement.

It is to be hoped that some other reports will be received, for its path must have been of extraordinary length, even if it was only travelling at ten miles per second, which is the almost irreducible minimum for a meteor.

A third observer saw it from indoors, appearing from above the window and falling vertically down the panes. It is a reasonable assumption, for a meteor of so great duration, that it first appeared at a height of 100 miles and reached within 30 miles of the earth. If so, its approximate path would be from above 25 miles off Bridlington to the coast of Denmark, north-east of Heligoland. The flight would be 360 miles, or rather over 10 miles per second.

Bootham, York.

J. Edmund Clark.

RECENT WORK OF THE GEOLOGICAL SURVEY OF THE UNITED STATES.

I.

Owing to the fact that much of the sphere of operations of this Survey lies in a new country, it is compelled to undertake a great deal of work of a class which does not usually fall to the lot of a body of geologists; chief amongst this stands topographical work. It was found that large tracts of country were unmapped, or else that such maps as did exist were worthless for geological purposes; so the Survey set itself to produce the necessary maps, and a very considerable advantage is likely to accrue to the country from the two types of survey being directed by one organisation. A map that is good enough for the reception of geological lines, is capable of all the uses for which a small scale map is ever available, while the employment of men who understand something more of the origin and types of topographic features than map-makers usually do, must conduce to the more accurate generalisation and delineation of surface features.

It is from this point of view that the monograph of topographic methods by Mr. H. Gannett[1] is likely to be of considerable use, both on the staff of the Survey, for whom it was primarily designed, and elsewhere. In addition to giving a concise description of the chief instruments employed and the methods of using them, this work contains a set of logarithmic and other tables for use in the field, with a short account of the method of origin of the chief surface features; this shows the usual types of contour and outline special to different cases, and it is so written as to give those charged with the sketching of these features some rough guides for the better delineation of them. The same work gives a map to show the progress of the topographic map executed by the Survey, and the contributions toward this work by other bodies, such as the following: The survey of the Fortieth Parallel, Hayden's survey of the Territories, Powell's Rocky Mountain survey, the U.S. Coast and Geodetic survey, the U.S. Lake survey, the General Land Office, the surveys of various States, the Engineers of the U.S. Army, several railway, astronomical, and private surveys, and the Town and County maps.

The completed maps will be on the scales of one mile and two miles to the inch, and the size of the sheets will be so regulated that all sheets on the latter scale will contain one-half, and those on the former, one-quarter of a degree, both of latitude and longitude.

One of the bulletins[2] contains a series of sketch maps showing the systems of primary triangulation adopted by this Survey and its predecessors and coadjutors. Another most useful publication, also by the same writer, is a set of geographical dictionaries of the several States; of these, the following are already published: Rhode Island,[3] Massachusetts,[4] Connecticut,[5] New Jersey.[6] Each of these "is designed to aid in finding any geographic feature upon the atlas sheets of the State, published by the U.S. Geological Survey. It contains all the names given upon those sheets, and no other. Under each name is a brief statement showing the feature it designates and its location, and opposite to it is the name of the atlas sheet, or sheets, upon which it is to be found." The heights of many important points, the length of many streams, and the areas of townships are given. It need hardly be said that such a task as this is one which might with great advantage be taken up by the Ordnance Survey at home, and the exact latitude and longitude, as given on the map, might be added for the purpose of precision in location.

An article by Mr. Gannett, in one of the annual reports,[7] deduces from the contoured maps some useful estimates of the height of most of the States in the Union, and the average elevation of the whole country. From this we gather that, while the country contains 200,000 square miles under 100 feet in height, there are nearly 20,000 square miles above 10,000 feet. The largest part of the area, half a million square miles, is between 500 and 1000 feet; the loftiest State is Colorado, closely followed by Wyoming 6700, and Utah 6100 feet, while the average elevation of Delaware is but 60 feet. The average height of the United States is 2500 feet. This article is illustrated by a beautiful orographic map of the country.

Turning now to publications of a more strictly geological interest, we may say a word or two about their character as a whole. In addition to the maps, of which the issue has now begun—these consist of three sets, the annual reports, monographs, and bulletins—statistical papers on the mineral resources of the States are published annually as well.

It is not quite easy to see what is the guiding principle underlying the division of these different works. The monographs are of course reserved for important and original researches bearing on all branches of geology. The annual report contains an account of the work executed within the year, together with a collected set of the more important investigations completed within the same period. These do not appear to differ in any marked degree from the bulletins in character, while they are decidedly bulky and difficult to handle and read. They are, however, profusely illustrated, and may presumably be taken as the more popular of the publications—works intended to be used by those seeking for information on soils, water, mines, and such-like topics—and as containing the researches of interest to the ordinary citizen or reader. This idea seems to be borne out by the amount of rather rudimentary matter given, occasionally in somewhat high-flown language, in these papers. Presumably the form of language employed is well understood in the States; but, over here, one cannot help thinking that simpler language would be a more fitting garment for such elementary ideas. The bulletins as a rule contain simple and straightforward statements of fact, with theory kept well in subjection; they consist of descriptions of particular areas, accounts of work in the field, the laboratory or the cabinet, palæontological and correlation papers, and compact pieces of petrological investigation.

Hitherto the annual reports have been loaded with a mass of details which, after once being presented to Congress, need hardly have gone further, such as the travelling bills of each exploring party, and other statements of accounts. We are glad to notice that now the administrative report of the director and those of the heads of divisions are bound with that account in a separate volume, while for several years the work on irrigation has been placed within separate covers.

We pass now to papers dealing with physiography from a standpoint more or less geological, and generally with the idea of providing matter of use to the general public. In the first place stands the treatise by Prof. Shaler on soils.[1] After a preliminary description of the average soil and its composition as regulated by the amount of stony and organic constituents which it contains, certain types of soils are classified as follows:—

Cliff-talus soils.
Glaciated soils.
Volcanic soils.
Soils of recently-elevated ocean-bottoms.

The chief formative agencies are in each case described, and the peculiar suitability of certain soils for particular purposes, such as talus soils for vineyards, is pointed out. The author then turns to the slow disintegration of glaciated surfaces contrasted with the easily rotted and fertile volcanic soils, and describes the succession of vegetable organisms in reclaiming new soils, and gradually rendering them suitable for tillage, beginning with the most humble, and passing up to the more conspicuous plants, and those useful for the purposes of man.

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[1] *Monograph* xxii., "A Manual of Topographic Methods," by Henry Gannett. (1893.)

[2] *Bulletin* 122, "Results of Primary Triangulation," by Henry Gannett. (1894.)

[3] *Bulletin* 115, "A Geographic Dictionary of Rhode Island," by Henry Gannett. (1894.)

[4] *Bulletin* 116, "A Geographic Dictionary of Massachusetts," by Henry Gannett. (1894.)

[5] *Bulletin* 117, "A Geographic Dictionary of Connecticut," by Henry Gannett. (1894.)

[6] *Bulletin* 118, "A Geographic Dictionary of New Jersey," by Henry Gannett. (1894.)

[7] Thirteenth Annual Report of the United States' Geological Survey, 1891-1892. (1893.)

[1] Twelfth Annual Report of the United States' Geological Survey, 1890-91. (1891.)

We next proceed to the ordinary types of soil in the valleys and plains, and opportunity is taken to give the life-history of soil from its first separation from the parent rock, all through its slow journey down the hillside, until it passes out to the streams and the sea. The action of frost and rain, of snow and wind, of carbonic acid and oxygen, but not of the very important humus acids, is given in full detail, and the great importance of widespread forest vegetation in preparing the soil for subsequent tillage by deep disintegration is rightly insisted on. The pumping of air in and out of the soil by rain and evaporation is shown to be of vast use, not only to the larger plants, but to the bacteria and fungi, which are of such great import in the life and death of higher organisms.

A capital series of pictures illustrates this monograph; one can only wish that in all cases the localities were specified. The function of roots, whether alive or dead, is well described. Darwin's work on earth-worms is referred to, and the operation of beetles, ants, crawfish, burrowing birds, reptiles, and rodents dealt with. A section of the paper relates to deposited soils, and great stress is laid on the circulation of soil and the functions of materials, which are the survivals of rocks which may have long ago disappeared, but whose influence in the soil does not pass away for very long periods. Certain peculiar soils, such as those of swamps, marine marshes, and sand dunes, are not neglected, and prairie soils are explained as due to the destruction of forests by fire. Man and the soil succeeds, and it is pointed out how great an action and reaction there is between these two, so that not only the distribution of disease, but even that of slavery can be shown to have a distinct direction with the soil. The following words may be noted in conclusion: "A heedless neglect of our duty toward it has led to the destruction of the soil over an aggregate area of not less than 4000 square miles. This means the loss of food-giving resources which would be sufficient, with proper care, to support a population of about one million people."

Prof. Shaler contributes to another annual report[1] a valuable and original article on the geological conditions of harbours. The following types are of importance in the United States, and it would be easy to recognise them elsewhere:—

Delta harbours; the Mississippi.
Re-entrant Delta harbours; Mobile Bay.
Glacial or Fiord harbours; Cape Breton.
Mountain Range harbours; Lower California and North of Puget Sound.
Moraine harbours; East end of Long Island.
Lagoon and Sand-bar harbours; Chatham harbour.
Sand-spit and Travelling Beach harbours; Provincetown harbour on Cape Cod.
Coral Reef harbours; Florida and Atolls.
Volcanic Crater harbours; not known in the States.

Prof. Shaler points out how important good harbours are in developing a race of sailors, and through them acquiring commerce and influence. His text is pointed by reference to the fact that the English-speaking race, or their kindred, the Dutch, possess nine-tenths of the valuable islands beyond the limits of Europe, and that North Europeans bid fair in time to dominate every part of the world fit for their occupation. "These considerations make it plain that the way to national power is over the waves, and that this way is the natural path of our race."

It is essential that a good harbour should fulfil the following conditions:—

It should be protected from the incursion of heavy waves.

There should be a deep and roomy channel from the anchorage to open water.

There must be ample room to receive and discharge cargoes.

It should be convenient for access from the interior.

In addition to this, it should be roomy, not in the path of heavy currents, not liable to shifting channels or deposits, nor likely to be obstructed at any time by ice. Harbours may be injured in greater or less degree by floods, winds, tides, by movements of the solid land, and by the indirect consequences of all these causes. The great preservers are the scour of tides and currents; the great destroyers, sediment and the growth of organisms. The action of sediment is fairly well understood and allowed for by engineers, but the influence of animals and plants is here dealt with in more detail than we remember to have seen elsewhere. The protecting work of algæ and seaweed is thoroughly explained, and the "eel-grass" (*Zostera maritima*) described in detail; this seems to have great influence in arresting the deposit of sediment, and causing the silting-up of harbours. The general operation of the tide-water grasses is to diminish the area of the harbour, and to deepen the channels which remain; that of mangroves is to occlude the harbour by cutting out the storage of water at high tide. The destructive work of plants appears to far exceed that of polyps. The article concludes with a review of the whole coast-line of the States, and the origin of all the important harbours.

The article on potable waters, by Mr. McGee,[1] contains a good deal of useful information, from the building of cisterns to the fouling of well-water by cesspools. Direct rain-water supplies are first dealt with, and the necessary filtering, which such water needs, described; next stream-water, and then that from shallow and deep wells, the latter source being termed *phreatic* water, whether from deep-seated springs, from artesian wells, or deep-pump wells.

Dr. A. C. Peale, who has done such an immense amount of unassuming and scarcely appreciated work for the survey in past years, contributes a much more important paper on natural mineral waters of the country.[2] This includes a table of all mineral springs which yield more than 1000 gallons per hour; these number more than 120. Mineral springs are found to be usually associated with areas of sedimentary rock, particularly in the neighbourhood of mountain ranges, where they have suffered much disturbance, and where volcanic action is now, or recently has been, rife. The annexed classification is adopted:—

(A) Non-thermal.
(B) Thermal.
    (1) Alkaline.
    (2) Alkaline-saline.
    (3) Saline.
    (4) Acid.

Each of the four last divisions is again divided into sulphated and muriated, and the last into siliceous as well. It is recommended that, in future, analyses shall conform to the scheme laid down by the Chemical Society of Washington, the most important points in which seem to be that solids shall be expressed in parts per million, and that the radicles actually found shall be expressed; while the chemist is at liberty to express, in addition, the probable state of combination in which the different ingredients occur. A brief account is given of the various purposes for which the more important waters are used, and two maps are appended; the second of these indicates the distribution of waters used commercially, and the first shows, as might be expected, the much wider dispersal of springs used as health resorts. A complete list of known springs closes the paper.

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[1] Thirteenth Annual Report of the United States' Geological Survey, 1891-92. (1893.)

[1] Fourteenth Annual Report of the United States' Geological Survey, 1892-93. (1894.)

[2] *Ibid.*

Mr. Merrill follows[1] with an account of the results of stream measurements. These are carried out by means of current meters, while the fluctuation of streams is recorded by nilometers. The "run-off" is expressed in second-feet (*i.e.* the water carried by a stream 1 foot wide and 1 foot deep flowing 1 foot per second), and the total discharge in acre-feet. The records have been continued monthly for many years, and yield a vast body of useful hydrographic information with regard to such rivers as the Missouri, Yellowstone, Rio Grande, Arkansas, Bear, and Snake Rivers. Curves are drawn where possible, and there are two maps, one delineating the rainfall of the States, and the other the run-off of the principal river basins. The latter quantity reaches a maximum in the eastern States, and at the southern end of the Rocky Mountains in Wyoming. Run-off is a function of rainfall and topography, with modifications introduced by other conditions, such as climate, structure, and vegetation; the ratio of run-off to rainfall is greater in mountain districts than in valleys.

A list of Californian earthquakes in 1893, by Mr. C. D. Perrine, is given in *Bulletin* 114.[2]

We have reserved till last the modestly told account of Mr. I. C. Russell's exploration of the Malaspina glacier, and his plucky attempt to reach the summit of Mount St. Elias.[3] Although unsuccessful he appears to have done enough to be able to point out a route which, with better luck and weather, will probably lead the way to this coveted point; and one cannot but hope that it may fall to the lot of this explorer to be the first climber to reach the top.

The Malaspina glacier is fed by all the southern and western ice-streams of the St. Elias range, which is but an outpost of a vast mountain area to the north. From the highest point which he reached, Russell saw this new land spread out before him like a map; but the point of view was not reached without much labour in the carrying of camp equipments, and in step-cutting up the great ice-falls. The glacier seems to be a great reservoir or sea of ice, stagnant or retreating, rather than a living and growing river of ice, and it deserves the term "piedmont glacier" bestowed on it by our author. It only pushes out into the sea at one point, Icy Cape, to the west, but elsewhere it is separated from the ocean by a belt of flat land of varying width. This border gave the same trouble to Russell's party that it has done to English explorers, on account of its icy-cold rivers and dismal swamps, somewhat mitigated in this case by the vast strawberry meadow in which the first camp was pitched.

Cutting a way through the great forest-belt, and pushing through the thick moraine at the margin of the ice, the party went across the glacier in the direction of the Chaix Hills, noting here and elsewhere the astonishing feature that the live moraine was often covered with a dense coat of vegetation, including trees of considerable age and size.

The Chaix Hills are made of stratified sands and clays containing marine shells, and some 4000 or 5000 feet in thickness; these deposits were evidently formed in the sea at the extremity of a glacier, and subsequently uplifted The uplift appears to have taken place along a line of fault extending from the Robinson Hills at the west, past the Chaix Hills, and on to the Samovar Hills and Pinnacle Pass at the east. Thence they pushed across the Agassiz and Newton glaciers, passing many ice-falls, the surface between which had a gentle and, even in some cases, a reversed slope. Capital descriptions of the scenery are often given, and numberless glacial observations recorded.

Although the party camped for twelve days at the entrance of the amphitheatre at the head of the Newton glacier, the weather only permitted of one advance during the time. They then reached an altitude of 14,500 feet on the col between the summit of Mount Newton and that of St. Elias; but here they found themselves forced to return, as they had not strength to accomplish the 6500 feet between themselves and the summit in addition to the labour of returning to camp that night. It was concluded that it would be necessary to camp on the col itself, when a final attempt of the peak was made. A second effort was made, but the avalanches and the dangerous condition of the snow compelled a speedy retreat, and, bad weather setting in, they were obliged to abandon the attempt, and confine themselves to investigations on the glacier at lower levels, and on its margin. They had, however, reached high enough to obtain a glorious panorama extending to Mount Fairweather, 200 miles away to the south-east, and to mountains of equal altitude and distance to the north-west. They looked to the north over a great "land of nunataks," a vast area of snow 8000 feet high, dominated by peaks rising yet 4000 feet higher.

The expedition then retreated down the glacier to where the Yahtse River emerges from its cavern of ice; thence they went along the shore to Yakutat Bay, exploring the edge of the ice on the way, and then they extended their survey along Disenchantment Bay, which, judging from the vivid description given, might well dispense with the first syllable of its name. It appears to be a charming region of mountains, glaciers, and bays, which may well in the future attract the notice of travellers and climbers in search of new ground.

The height of Mount St. Elias was determined, within a plus or minus error of 100 feet, as 18,100 feet. The work at the edge of the ice gave many useful results. The supremacy of the water action in the sea, and even in the rivers, soon made itself felt in the characters it induced on the material transported by the ice, but laid down in the water; the ice frequently traversed unconsolidated material without disturbing it, and ridges of gravel, very like kames and eskers, were found to have been deposited by glacial rivers when at a higher level than that at which they at present flow.

On the main mass of the glacier there are many new facts recorded; but we have room for only a few of them. Dykes of veins of hard ice, frozen in fissures, are added to the many structures in which ice resembles less transient rocks. A rough sorting of débris takes place on the ice surface as the rocks roll down the numerous irregularities, due to melting and other causes; moulins become filled with gravel when the water-action ceases, and then, becoming preserving causes, give rise to "sand cones," which recall the earth pillars of the Tyrol. In the stationary parts of the ice numerous lakelets of strange hour-glass-shaped section occur. Lakes of the same method of origin as the Märjelen Lake are frequent where the ice passes nunataks and valleys. The main drainage of the ice is englacial or subglacial, and surface streams are rare and evanescent. Finally, these streams tend to cut their channels upward through the ice as their floor gets coated with débris, which not only checks mechanical erosion, but is a bad conductor of heat. An immense amount of water-rolled material takes its place amongst the more truly glacial detritus, and it is somewhat noteworthy that nothing corresponding to *moraine profonde* is described by Mr. Russell in his report.

The strictly palæontological work in the period under review is rather scanty. It includes a short paper on the American Tertiary Aphidæ, by Mr. Scudder.[1] This comprises a list of known species and five plates. A monograph, by the same author, on the Tertiary *Rhynchophorous Coleoptera*[2] contains descriptions and figures of a great number of new genera and species, 193 species having been found in the older American Tertiaries, while only 150 species have been described from the whole of the European Tertiary rocks. This makes a first instalment towards a history of fossil Coleoptera.

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[1] Fourteenth Annual Report of the United States Geological Survey, 1892-93. (1894.)

[2] *Bulletin* 114, "Earthquakes in California in 1893," by C. D. Perrine. (1894.)

[3] Thirteenth Annual Report of the United States Geological Survey, 1891-92. (1893.)

Mr. Whitfield has written a description of the mollusca and crustacea of the Miocene formation of New Jersey.[3] This work, which is illustrated by twenty-four plates, describes the only brachiopod and cirripede found in these beds, with a large number of gasteropoda and lamelli-branchiata, many of which are now described for the first time.

Mr. C. R. Keyes gives, in *Bulletin* 121,[4] a bibliography of North American Palæontology 1888-1892. This comprises 251 pages, and in an alphabetical series are included a list of names of authors, with a short synopsis of essential points, including lists of genera and species described and figured, a title-index, and subject entries and cross references. A list of subjects is given in the introduction, and also a list of works examined, which may save a good deal of trouble. The list is by no means perfect, but it is undoubtedly a most important contribution to bibliography.

In a subsequent article it is proposed to deal with researches in petrological, dynamical, and stratigraphical geography.

OSTWALD'S ENERGETICS.

IN the February number of *Science Progress* there is an interesting article, by Prof. Ostwald, on "Emancipation from Scientific Materialism." There are so many vague fallacies underlying it, that it would hardly be worth answering, only that there is considerable risk that others, chemists especially, may be carried away by the arguments of one whom they rightly value as a leader in their own domain when he descants positively about the realm of mechanics.

Prof. Ostwald begins by saying that the current view of a mechanical universe fails in two respects. (1) It does not fulfil the purpose for which it was designed, and (2) it is inconsistent with known truths. It is, in the first place, to be remarked that nobody who has considered the matter really seriously can maintain that atoms and motion must constitute the whole universe. Such a view leaves thought out of account, and all that can be held is that material phenomena are so explicable. Prof. Ostwald ignores such theories as that of vortex atoms, which postulate only a continuous liquid in motion; but, it may be, this is omitted because it is merely a way of explaining the atoms. He also ignores metaphysical questions, such as whether motion be not only the objective aspect of thought, and also whether an intuitively necessary explanation of the laws as distinct from the origin and consequent arrangement of phenomena is not postulated by the fact that the universe must be intelligible. Consequently his attempt to deal with nature in a purely inductive spirit is unphilosophical as well as unscientific. The view of science which he puts forward—a sort of well-arranged catalogue of facts without any hypotheses—is worthy of a German who plods by habit and instinct. A Briton wants emotion—something to raise enthusiasm, something with a human interest. He is not content with dry catalogues; he must have a theory of gravitation, a hypothesis of natural selection. This deadly science without hypothesis is far worse than the materialistic *ignorabimus* of Du Bois Reymond; it is the culmination of the pessimism of Schopenhauer.

Prof. Ostwald's first line of attack is that the materialistic hypothesis does not fulfil the purpose for which it was designed. When this is investigated, it turns out that all he means is that everything in nature has not yet been explained on mechanical principles. And long may it be so. The zest of science is discovery. If everything were explained—well, it is so far off we may wait till it comes to describe what will happen. He notices several things which are certainly not explained yet. Such, for instance, as why when atoms combine they produce a result so very different from their components. As nobody has yet suggested any reason why the atoms themselves possess the very curious properties they do, we can hardly expect a satisfactory explanation of why these properties change when they combine. Any way, the existence of an uninvestigated region of this kind does not create any reasonable doubt as to the foundations of the road that has led us well so far.

His second attack is deliberately founded on this, that mechanical hypotheses have not yet been found to explain everything. "I grant," he says, "that for many individual phenomena the mechanical analogues have been given with more or less success. But all attempts to completely represent the whole of the known facts in any department by means of some such mechanical analogue have resulted without exception in some unexplainable contradiction between what really happens and what we should expect from our mechanical model. This contradiction may long remain hidden; but the history of science teaches us that it sooner or later makes its inevitable appearance, and that all we can say with complete certainty regarding such mechanical similes or analogues—usually termed mechanical theories of the phenomena in question—is that they will doubtless on some occasion fail."

All that this really means is that we have not yet explained everything on mechanical principles, and that when we do get a little way on, we are delayed again by something more that requires explanation. But surely this and nothing else is what we ought in all reason to expect. It is about the best test we have that we are on the right track. Prof. Ostwald cites optical theories as an example of the kind of failure he refers to. He seems for some extraordinary reason to imagine that the *elastic solid* theory of the ether is in some curious way specially connected with the mechanical hypothesis of the universe. It is far from being so. The mechanical theory of an elastic solid itself has been only very dimly foreshadowed, and Prof. Ostwald's contention that transverse vibration "presupposes a solid body" is in direct contradiction to Lord Kelvin's theorem that a liquid in turbulent motion could transmit transverse vibrations. Even Lord Kelvin's elastic solid ether in a state of tension could exist if it be infinite, so that here again Prof. Ostwald is mistaken in saying that, because it could not be stable if finite, it can have no physical existence. And finally Prof. Ostwald takes refuge in the as yet unexplained constitution of an ether whose properties were discovered by assuming them to be mechanical, and were only discovered about thirty years ago, and have not been seriously investigated until within the last ten years. Surely no argument can be based upon the fact that there are limits to our present knowledge.

Prof. Ostwald's third attack opens out a new view. We see here a human reason for his desire for emancipation from the mechanical hypothesis. He is dissatisfied with Du Bois Reymond's *ignorabimus*. But even Du Bois

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[1] Thirteenth Annual Report of the United States Geological Survey, 1891-92. (1893.)

[2] *Monograph* xxi., "The Tertiary *Rhyncophorous Coleoptera* of North America." By Samuel Hubbard Scudder. (1893.)

[3] Monographs of the Geological Survey of the United States, vol. xxiv. (1894.)

[4] *Bulletin* 121, "A Bibliography of North American Palæontology, 1888-1892," by C. R. Keyes. (1894.)